REPORT OF SURVEY CONDUCTED AT

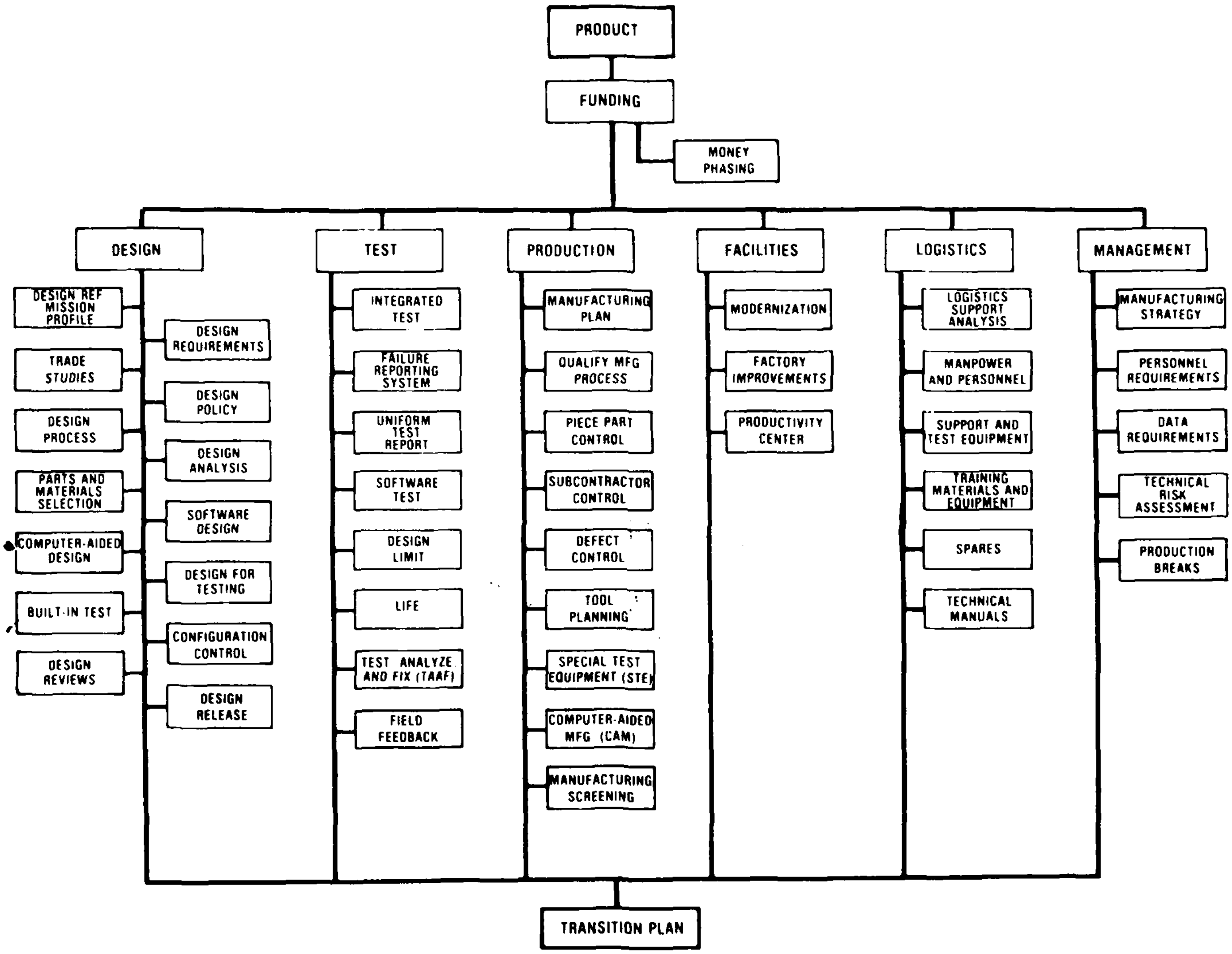
ITT
DEFENSE TECHNOLOGY CORPORATION
AVIONICS DIVISION

CLIFTON, NEW JERSEY

SEPTEMBER 1987

DoD 4245.7-M, "TRANSITION FROM DEVELOPMENT TO PRODUCTION"

CRITICAL PATH TEMPLATES



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The purpose of the Best Manufacturing Practices (BMP) survey conducted at this facility was to identify their best practices, review manufacturing problems, and document the results. The intent is to extend the use of progressive management techniques as well as high technology equipment and processes throughout the U.S. industrial base. The actual exchange of detailed data will be between contractors at their discretion. A company point of contact is listed in the report

The intent of the BMP program is to use this documentation as the initial step in a voluntary technology sharing process among the industry.

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STATEMENT "A" per Adrienne Gould
Office of the Assistant of the Navy,
Attn: RDA-PI, Washington, DC 20360-5000
TELECON 4/27/90 VG

SECTION 1

INTRODUCTION

1.1 SCOPE

The purpose of the Best Manufacturing Practices (BMP) review conducted at ITT Defense Technology Corporation, Avionics Division was to identify best practices, review manufacturing problems, and document the results. The intent is to extend the use of high technology equipment and processes throughout industry. The ultimate goal is to strengthen the U.S. industrial base, solve manufacturing problems, improve quality and reliability, and reduce the cost of defense systems.

To accomplish this, a team of DoD engineers reviewed ITT Avionics (ITTAV) in Clifton, NJ to identify the most advanced manufacturing processes and techniques used in that facility. Manufacturing problems that had the potential of being industry wide problems were also reviewed and documented for further investigation in future BMP reviews. Demonstrated industry wide problems are submitted to the Navy's Electronics Manufacturing Productivity Facility (EMPF) for investigation and resolution.

The review was conducted on 22-25 September 1987 by a team of Navy personnel identified on page 2 of this report. ITT Avionics is primarily engaged in design, development, and production of command, control, communications, and intelligence equipment.

The results of BMP reviews are being entered into a data base to track best practices and manufacturing problems. The information gathered will be available for dissemination through an easily accessible central computer. The actual exchange of detailed data will be between contractors at their discretion.

The results of this review should not be used to rate ITTAV among other defense electronics contractors. A contractor's willingness to participate in the BMP program and the results of a survey have no bearing on one contractor's performance over another's. The documentation in this report and other BMP reports is not intended to be all inclusive of a contractor's best practices or problems. Only selected non-proprietary practices are reviewed and documented by the BMP survey team.

1.2 REVIEW PROCESS

This review was performed under the general survey guidelines established by the Department of the Navy. The review concentrated on the functional areas of design, test, production, facilities, logistics, management, and transition planning. The team evaluated ITTAV's policy, practices, and strategy in these areas. Furthermore, individual practices reviewed were categorized as they relate to the critical path templates of the DoD 4245.7-M, "Transition From Development To Production." ITTAV identified potential best practices and potential industry wide problems. These practices and problems and other areas of interest identified were discussed, reviewed, and documented for dissemination throughout the U.S. industrial base.

The format for this survey consisted of formal briefings and discussions on best practices and problems. Time was spent on the factory floor reviewing practices, processes, and equipment. In-depth discussions were conducted to better understand and document the practices and problems identified.

1.3 BMP REVIEW TEAM

Team Member	Agency	Role
Alan Criswell (215) 897-6684	**Naval Industrial Resources Support Activity** Philadelphia, PA	**Team Chairman**
Dick Kluesner (812) 854-3849	**Naval Weapons Support Center** Crane, IN	**Team Leader** Design/Test
John Wiegand (812) 854-3240	**Naval Weapons Support Center** Crane, IN	
Larry Halbig (317) 353-7075	**Naval Avionics Center** Indianapolis, IN	
Larry Robertson (812) 854-1695	**Naval Weapons Support Center** Crane, IN	**Team Leader** Production/Facilities
Mike Fredrickson (619) 446-7706	**Electronics Manufacturing Productivity Facility** Ridgecrest, CA	
Ron Thompson (812) 854-1695	**Naval Weapons Support Center** Crane, IN	
Bob Cormack (201) 323-7475	**Naval Air Engineering Center** Lakehurst, NJ	
John Essex (317) 353-3953	**Naval Avionics Center** Indianapolis, IN	**Team Leader** Management/Logistics
Ernie Renner (202) 692-1146	**Office of the Assistant Secretary of the Navy (Shipbuilding & Logistics)** **Reliability, Maintainability, & Quality Assurance** **Production Assessment Division** Washington, DC	

SECTION 2

BEST PRACTICES

The practices listed in this section are those identified by the Navy BMP survey team as having the potential of being among the best in the electronics industry.

2.1 DESIGN

DESIGN PROCESS

Design for Production

The design process reflects a sound design policy and proper engineering practices. Concepts are selected, demonstrated, and validated based on the feasibility of producing a system employing these concepts. Design is based on proven manufacturing methods and processes to produce the system. Much attention is given to design for production. Cost bogies as an element of a DTUC system are currently being developed.

The potential to produce a system is investigated carefully during the system design phase. Methods and processes are proven by pilot quantities and experiences gained from previous programs. Producibility engineering and planning is fostered through close interaction between design engineering and production engineering. Manufacturing coordination is part of production drawing release. Co-location of production engineers permits effective participation in design concept development. The design process ensures both performance and producibility considerations for packaging of electronics components. "Producibility Guidelines" in each of the key design disciplines are followed.

COMPUTER AIDED DESIGN (CAD)

CAE/CAD/CAM System

A series of PRIME, VAX, CALMA, ZYCAD, and PE CAE tools networked together is used to perform digital designs, RF designs, hybrid designs, software engineering, test engineering, CAD/drafting, manufacturing, and simulations. They have software that is capable of performing modeling, simulation, stress analysis, reliability, maintainability, parts selection, configuration, and engineering, cost, and support data collection. The software includes the rules and guidelines for design and special processes. A controlled common database is the key to linking these different tools.

The CAE design process is well documented in the form of guidelines, procedures, and flow charts. The process stresses the importance of rigorous design analysis to do the job right the first time. The digital design function has developed enough confidence in their Electronic Design Management System (EDMS) and ZYCAD simulator that they have eliminated bread-boarding in the design of gate arrays and printed wiring boards. Contracting for circuit routing with ASI Pennsylvania has allowed for the integration of the digital schematic design with the generation of documentation for a final electronic package. The mechanical design function uses various software packages, in addition to ANSYS software, to analyze thermal and structural properties of their designs. They also use MEDUSA 3D modeling to develop computer generated drawings. The analog design function will be purchasing their own CAE system in the near future.

DESIGN REVIEW

Design Review Process

Design reviews are scheduled and organized per ITT Avionics standard practice SP-220.1.

Formal design reviews are scheduled at key milestones from concept through design, development, and production phases. These reviews detect problems at an early stage in the design process, resulting in minimized redesign and rework. Attendance by each functional area is mandatory. This includes systems engineering, electrical design, software, mechanical engineering, test engineering, manufacturing, industrial engineering, logistics, product assurance, quality, and configuration management. Design reviews are categorized by types (concept, functional, etc.), and each type requires certain documentation be presented and supported by data analysis. A centralized design review file is maintained. The design reviews are conducted in a positive fashion, stressing adherence to project objectives and utilization of corporate experience to insure delivery of a reliable product.

DESIGN POLICY

Design Policy (SP-219.1)

This facility has a documented design policy tailored to their product line. The policy emphasizes basic design fundamentals, disciplines, and practices. Standard practices and guidelines have been written or are in-process. The guidelines are being integrated into a comprehensive database and in engineering standards and procedures. A design review standard practice (SP-220.1) requires formal design reviews with specific milestones, checklists, documentation, responsibilities, corrective action procedures, and approval procedures.

Producibility, Testability, Reliability and Supportability (PTRS)

The objective of PTRS is to develop operating procedures that ensure the attributes of producibility, testability, reliability and supportability are incorporated into the design from inception. This development will result in:

- Modification of the design review Standard Practice (SP-220.1)
- Generation of an upgraded design activity flow chart
- Generation of a matrix showing functional involvement and expected contributions/outputs during the various design phases.

These operating procedures will formalize and define the "who, what, and when" for the design process.

DESIGN ANALYSIS

Automated Reliability and Maintainability Analysis

One of the automated design analysis tools being developed is an automated Reliability and Maintainability Analysis Program (RAMCAD). This program, which is already being used by design engineers, allows them to predict approximate reliabilities as soon as initial part selection is made. As additional analysis and testing is performed, the reliability prediction becomes highly accurate. RAMCAD will ensure that reliability and maintainability are incorporated into the design process up-front. Present and future capabilities of the program include:

- Hardware Reliability Analyses
- Thermal Analyses
- Stress Analyses
- Stress Reliability Block Diagram Tools
- Systems Availability Modeling
- BIT and Fault Tolerance Effectiveness
- Failure Modes and Effects Analyses
- Maintainability Assessments

SOFTWARE DESIGN

Software Design

Software design receives the same degree of discipline as hardware design early in the system design. Tools have been developed to use a "rapid prototyping" approach (DOD 2167 incremental development) in lieu of the "classical" approach (sequential development) in designing software. This approach provides better visibility, identifies problems earlier, software is delivered with less instructions, reduces hardware memory, and provides more efficient software. During requirements analysis, software developers determine what is to be done in software and hardware. The prime aim is to define the system's functions, not the program. Operating Instructions (OI) have been generated to perform various quality tasks, and software standards define the way to proceed. All software designs start with the top level system design. Computer software components (modules) are defined, developed individually, and integrated together. ADA standard high level language is used as the program design language. A hard design review is conducted internally before reviewing with the customer. A software test/simulation facility has been developed to test and maintain software before, during, and after field testing. This test/simulation facility provides data collection, monitoring, and analysis to provide insight to clear definitions and measures of computer software reliability and performance.

DESIGN FOR TESTING

Design for Testing

Test and inspection are recognized as integral functions of the production and operational environment. Product design allows for proper test and inspection capabilities using various types of automatic testing approaches. Policies and guidelines governing design for testing are well established and inserted before the conclusion of the design process.

Engineering design practices, in the form of standards and guidelines, based on production studies and experience, define inspection, test, and evaluation requirements. Criteria maximizes inspectability and minimizes the need for special manufacturing tests and unnecessary test equipment. Design reviews ensure that design for testing considerations are completed before design release.

2.2 TEST

INTEGRATED TEST

General Approach

Test requirements are identified early in the product design process. Test equipment designs start with the preparation and generation of the test and evaluation master plan and follow a top-down approach from system level to sub-assembly level. Testability guidelines are sectioned into digital, analog, power supply, hybrid, etc. categories. The testability guidelines currently being written emphasize partitioning, visibility, and control to ensure maximum test effect. These basic guidelines are imposed on the designers.

Automated Test Project (IMIP Program)

The Automated Test Project is an Air Force IMIP Program. The objectives are as follows:

- Network automatic test equipment to a central database
- Perform test programming on a common programming station
- Line engineering CAD/simulation to automatic test equipment
- Archiving and configuration control of test programs
- Collection and analysis of test failure data on a common database

2.3 PRODUCTION

MANUFACTURING PLAN

Initial Process Development Via Experimental Statistics

There were multiple processes that used experimental statistics in the initial set-up of the process control parameters. The Taguchi method was used in the drilling process and the wave soldering process. The Taguchi methods would start with an initial brainstorming session to generate a list of possible parameters that would impact the quality of the hardware coming out of the process. After the significant or "robust" parameters were determined, the optimum settings that would provide the least number of defects in the hardware were developed. This method of process development was used for various boards and assemblies.

For example, in the wave soldering process, 18 different process controlling parameters were generated via a brainstorming session. After the Taguchi methods were incorporated, two or three parameters were found to be insignificant. The optimum settings for the other 16 parameters were determined for various assemblies that were being wave soldered. They found, for instance, that some assemblies needed a lot of oil in the soldering process while others needed little or none.

The incorporation of experimental statistics in the early stages of process development was a time and cost saver with the incorporation of statistical process control after process development provided a controlled soldering process.

Equipment Maintenance

Equipment maintenance throughout the manufacturing process was extensive. On the printed circuit board drilling machine, the heads were checked for alignment every week and the drill bits were resharpened every 1,000 holes. The results of the maintenance were documented and placed directly on the drilling machine. In the component insertion process, both the axial lead inserter and the DIP inserter went through preventative maintenance on a weekly basis (every Monday, second shift). The maintenance, on an average, would take up to four hours every week. There was a significant amount of cooperation between the production floor and the maintenance personnel. Due to their maintenance on both of these machines, they have experienced very little downtime. On the wave soldering machine, maintenance was performed every day that it was used. The entire maintenance program assisted greatly in the increase in quality on the production floor.

Preventive maintenance of production process equipment is extremely important. This has proven to reduce process problems and production downtime. This is one of the functions of the advanced manufacturing engineering (AME) organization. As new manufacturing equipments are very carefully transitioned from AME to production, the personnel are trained and frequency of maintenance is determined. This maintenance is performed on second shift, when possible, to reduce production downtime. Preventive maintenance is a very effective tool which helps to reduce cost of product and make scheduling realistic.

Design of Test and Quality Data Collection Points

In the early stages of planning the flow of manufacturing assemblies, the production engineering staff determines the points in process when both test and quality data is collected. At the same time, the type of data that needs to be collected is defined. It was evident on the manufacturing floor that this information was collected and reported on a scheduled basis. Throughout the plant, current quality information was posted at each of the major manufacturing processes. In addition, there was extensive material, component, and assembly functional testing throughout various stages in the assembly fabrication process.

Quick Reaction Manufacturing

A special, non-formalized, quick reaction shop is in operation. This shop is part of Quick Reaction Manufacturing (QRM). The QRM operation could be referred to as a "Producibility Laboratory," but whatever the name, the function and mission are the same. The QRM shop work is performed by highly skilled and versatile personnel whose job title is construction technicians. These technicians, along with assigned transition engineers, are the key personnel to accomplish the basic elements of the QRM philosophy, which are:

- To quickly produce urgently needed hardware with minimum documentation and external support
- To generate the necessary manufacturing documentation to facilitate transition into the mature production shops.

QUALIFY MANUFACTURING PROCESS

New Process/Equipment Prove-Out

A significant amount of resources is spent developing new production techniques prior to implementation on the production floor. Engineers learn the intricacies of new equipment before it is purchased. New equipment is proven-out and associated processes are developed before Industrial Engineering can schedule the new process for use. They also perform a significant amount of research and need identification. Where research of the industry does not identify equipment that meets their needs, they will develop new processes and associated equipment. Two significant examples of these R&D efforts are a vacuum bag laminating system for PWB modules and an infrared hybrid removal system. Operating procedure development, operator training, and the development of engineer/operator teams make the development to production transition smooth. This up-front dedication of resources to process proving significantly reduces the potential for schedule delays and production hardware scrap caused by the use of immature processes.

PIECE PART CONTROL

Automated Receiving/Inspection and Material Control

A large degree of automation is utilized in the material receiving and incoming inspection areas. This includes equipment which removes ICs from tube packages, tests them, and repackages acceptable ICs in tubes. Combined with computerized material tracking systems and a just-in-time material requirement prediction system (MRP-II) for timely procurement, part storage and part shortage problems are minimized. First-in, first-out (FIFO) issuance to production minimizes part storage and the common problems associated with it (loss of solderability, etc). A shared computer system linking procurement, material planning, receiving, and production operations (material utilization) ensures manufacturing has the parts it needs when they are needed.

Sample based solderability testing is performed upon receiving. Part solderability is also ensured by specifying detailed part lead material and finish requirements. A vendor rating system is used to correlate both receiving and production identified problems with the original material. Where vendors show an inability or unwillingness to supply the needed parts, they are dropped from the supplier lists. Original equipment manufacturer parts are used whenever possible, avoiding the storage and quality problems periodically experienced in procurement from distributors.

Incoming Inspection

The incoming inspection program consists of 100 percent testing of ICs and axial leaded components at a temperature range of -54 degrees to +125 degrees C. Their failure rate after component screening is less than 0.3 percent. Even though these components have been vendor screened, the added screening is cost effective.

SUBCONTRACTOR CONTROL

Subcontractor Control

The quality section that provided supplier control incorporated various activities to ensure quality products. In addition to normal end-item functional testing, in-house control on the subcontractor is provided. The in-house control consisted of production readiness reviews, capability surveys, and quality surveys. Before the subcontractor begins any work, a team determines their manufacturing capability. This eliminates the possible production problems with complex assemblies. During the production process, quality teams are sent out to insure that quality practices and specification requirements are being met. In addition to the audit functions, statistical process control and process optimization techniques are being implemented in the subcontractor plants. The quality section also gave ratings to the various subcontractors and kept them informed on the status of their ratings. An on-site representative verifies the manufacture of the parts while in process, not just a final test. Subcontractors that have the highest rating could be selected for new contracts.

Engineering Personnel in Procurement

Three engineers with an average of 25 years experience are assigned to procurement to provide engineering support for procurement actions. They insure unambiguous definition of all subcontracted items. They participate in technical interchanges with vendors. They critically review performance specifications, conduct technical reviews, prepare statements of work, review responses to requests for proposals, participate in pre-award surveys, provide inputs on vendor capabilities, and identify risk areas. They participate in the resolution of technical problems with personnel from other functional areas.

DEFECT CONTROL

Quality Circles

Management is committed to problem identification, analysis, and resolution. Quality circles are formed on a voluntary basis to discuss work related problems, investigate causes, and recommend solutions. Circles are normally made up of from five to twelve persons, crossing functional groups when appropriate. They may be formed in any work area, program area, or functional group with permission of their management. All members, leaders, and facilitators receive training to allow them to function properly in their respective roles. The primary objective of the quality circle program is quality improvement by using the ideas of people in the workplace to solve problems.

Every completed problem and its suggested solution is presented to management. After hearing the presentation, management responds to the circle within one week. When measurable, quality circles follow-up on projects by calculating the effectiveness of the implemented solution. Quality circle members receive recognition for their activity and are presented awards for benefits gained. In the past year, a one-half million dollar cost reduction has been realized as a result of quality circle related activities.

Implementation of Statistical Process Control

Statistical process control is a central element in the entire manufacturing process. As a responsibility of the manufacturing department, operators sample their processes on a regular scheduled basis to ensure constant optimal process operation. This was evident throughout the plant. Current quality and test information was posted at each of the major manufacturing processes. Out of control process conditions are recognized, recorded, and resolved by the operator as they occur. This allows for immediate operator response without any time lag associated with a quality assurance/manufacturing communication interface. In a collateral function, quality assurance personnel inspect and track defects in production hardware. In addition, field failure data (where available) is also used to evaluate production process operation. This three level tracking system allows for continuous process review with both in depth analysis and immediate response. A significant management focus and frequent reviews ensure continuous process optimization. The Integrated Corrective Action Program (ICAP) panel acts to resolve any significant problems that occur.

Process Controls

The automated PC facility is highly process controlled and quality oriented. Both the photolithographic "Gold Room" area and the multilayer printed wiring board areas are atmosphere controlled clean rooms. Atmospheric controls maintain both temperature and humidity at optimum levels. These controls assure stability of both photolithographic and multilayer materials which reduce defects during processing. Additional PWB manufacturing process controls include daily coupon analyses (microsections and microscopic inspection) to ensure that etch-back, inner layer plating, and board lamination are optimized. Plating baths are analyzed daily. Prepreg gel is checked with each new roll that is brought out of temperature controlled storage. By maintaining the prepreg at 0 degrees F, they are able to significantly extend the prepreg storage life. Inner layers are visually inspected and electrically tested after etching (prior to lamination). In this manner, unnecessary scrap is avoided. Utilizing a real time X-ray system, one board from each lot has its inner layer alignment checked after drilling. All final boards are 100 percent visually inspected and electrically tested.

2.4 FACILITIES

MODERNIZATION

Facilities Improvements/Modernizations

A dedicated facilities planning group was established to optimize utilization of existing facilities and perform long term planning for facilities. $38.1 million has been invested in facilities capital since 1982. $82.2 million has been invested in facilities and equipment capital since 1982. Modernization has been performed in the printed circuit fabrication, printed circuit assembly and test, final assembly and test, and the microelectronics facility. The facility planning is well coordinated with future planning, taking into account new manufacturing methods and processes.

Enhanced Repairability for Hybrid Packages

A technique for desoldering hybrid packages is under development. The prototype has been built and the production equipment is being designed. The equipment utilizes focused infrared beams that reflow the solder with a vacuum pick-up for the part. This equipment allows parts to be replaced without damaging pads or components, even on high lead density parts.

FACTORY IMPROVEMENTS

Automated Process Controlled Wave Soldering

While vapor phase and infrared reflow systems are used only in a very limited manner, the wave solder process is highly automated. A top of the line Hollis computer controlled CBS Mark II wave solder system is the heart of the wave solder process. Computer controlled and computer monitored, this system starts with a foam fluxer and fluxer air knife. Periodic flux viscosity measurements are made and recorded automatically. Out of tolerance conditions are prevented through constant recirculation and mixing of the flux and alcohol solvent. This inhibits alcohol evaporation. Next, the boards are heated utilizing both top and bottom side preheaters. Preheater function is controlled and monitored utilizing a thermocouple positioned below the adjustable conveyor. Finally, the board is subjected to a dual wave solder process. A dynamic/turbulent wave ensures SMT components are adequately soldered. The laminar wave completes the process for both the SMT and thru-hole parts. The wave solder process is completed by a 700 degree F hot air knife which removes any solder bridges. The wave is run with both oil and dry, depending on the assembly. In general, the use of oil is dependent upon PCB geometry and design, not the specific board material.

Automatic Conformal Coating

An effective conformal coating system (Integrated Technologies, Inc. Model CM2332) was developed that is also highly automated. Four pairs of spray nozzles are mounted on a traversing arm. By careful orientation of the nozzles (each in a different direction), each board is completely coated in two passes. Coating is applied with a thickness tolerance/control of 0.001 inch. Operators are merely required to load boards, start the machine, and remove the boards when a pass is completed.

Automated DIP Verification and Insertion

A totally automated insertion machine (Universal Uni-Mod DIP Inserter Model 6796A) is used in the mounting of DIPs. Leads are straightened and aligned as the parts are mounted. A brief electrical test characterizes each IC as it is prepared for loading. Through cross checking with standard characterizations stored in the computer memory, each IC is verified as correct before it is mounted. At the same time, correct DIP orientation is provided. The equipment was purchased with 250 characterizations, and they developed another 250 of their own due to their part mix.

Automated Part Mounting

Automated part mounting equipment (Universal Auto Insertion, Lead Bend and Crimp Model 6287A) performs a wide variety of operations. Automated equipment cuts axial leaded parts from the kitting reel (cutting the lead to pre-insertion length), forms the leads, inserts the part into the hole, cuts, and then clinches the leads. A light system is used to characterize each lot of boards to ensure any drilling variations are accounted for before part insertion. This is a quality system which allows part lead to hole separations of 0.015 inch (a very good ratio for solder flow). During kitting onto the tape reel, diodes and other polarized parts are oriented on the reel. A rotating table enables this system to position the board in a manner which ensures correct part orientation.

Automated Axial-Lead Part Kitting

An automated tape reel system (Universal Instruments Components Sequencer Model 2596B) removes a wide variety of axial leaded parts from the bulk parts tape reels on which they are purchased. As these parts are removed, they are tested for both capacitance and resistance. Parts which do not meet the computer controlled test parameters are evaluated for return to the vendor. Good parts are then retaped sequentially as a kitted reel for use with automatic part mounting equipment. In one particular application, as the control program for the part mounting equipment is developed, associated software simultaneously develops the program which the part kitting machine will utilize.

Automated Processes

The heart of the process control system is the utilization of on-line, real time automated process monitoring and control systems. Automated control and tracking systems have been incorporated throughout their facility. From the very beginning, their CAD/CAM system identifies their material needs. Procurement and receiving use computerized databases to stock and track material. During receiving, part solderability is checked. If the parts are issued to production and unused, they are recalled for retest in either six month (tin plated leads) or one year (solder coated leads) intervals.

From the start of the assembly process (and as far back as material procurement), computers are used for data collection, computer control, and process tracking. Automated testing operations are performed throughout a large number of manufacturing processes. This is essential to the continual process control and monitoring operations that are performed. Testability during manufacturing appears to be one of the many elements of their initial assembly design process. The high degree of automation has enabled a high degree of process characterization and the use of statistical process control. Overall, the commitment to automation has enabled them to produce in a high volume environment with a large product mix and strong process control.

Automated SMD Mounting/Positioning

Automated part mounting operations include the dispensing of adhesive and positioning of chip capacitors and resistors on mixed technology (thru-hole and SMT) boards. Automated positioning/mounting systems for leadless chip carriers and hybrids are also under development.

In-Line Cleaning

Immediately after the wave soldering operation, boards are manually loaded onto a Detrex in-line solvent cleaning system (three inches between the end of the wave solder machine and the cleaning machine) which incorporates both liquid and vapor cleaning stages. As the boards are frequently still warm from the wave solder operation, the cleaning solution is maintained at approximately 160 degrees F by another computer control system. Presently, the boards are moved from the wave solder machine to the cleaning system manually. An automated system is under conceptual development.

2.5 LOGISTICS

LOGISTICS SUPPORT ANALYSIS

Approach to Logistics

The logistician is elevated to an "equal partner" with his engineering and design peers. The function of logistics is managed in a realistic method of forethought and planning. The observed other approach is to manage the logistics function as an after-thought or "wrap-up" item.

A Logistical Engineer is assigned to each program to accomplish the following:

- Establish early and continuous involvement in the program
- Participate in design reviews
- Have sign-off responsibility on the design
- Have veto authority on all proposed design changes

The intent of the Logistical Engineer's program involvement is to assure a well transitioned supportability of the program during its entire life cycle. This is an innovative approach to the function of logistics, the result of which is the satisfactory accomplishment of all the logistic templates (i.e., support and test equipment, training, technical manuals, etc). This innovative, up-graded approach to logistics has largely been implemented and successful because of an emphasis from the "top-down," rather than from the "bottom-up" management approach. This high regard for logistics has resulted in a well organized and well located logistics department. The benefits of which are experienced in the smooth transition of logistics and life time program support.

Logistics Technology Transfer

A unique approach to dissemination of logistics support information within the divisions of ITT Defense Technology is utilized. Key representatives from each of the five divisions meet on an annual basis to exchange technical information on new technologies, problems, solutions, and logistics support methodology. The meetings last one day with follow-up action items to be worked on during the year. Correspondence between the divisions is maintained at the senior management level. This technique has enabled them to take advantage of lessons learned in each of it's Defense Technology Divisions, improving logistics support capabilities, and reducing costs normally associated with reinventing the wheel.

On-Line Logistics Support Analysis Database

Logistics engineers utilize an on-line Logistics Support Analysis (LSA) data base. Their influence begins early in the development process to explicitly address supportability and support requirements throughout design, development, and production process. Testability is enhanced through effective design review and timely feedback to design engineers.

Subjects such as built-in-test, test points, and emphasis on functional hardware design for maintainability is emphasized by experienced prior-service technicians. This has resulted in reduced mean time to repair of existing systems. The concept of vertical testability is emphasized by exercising built-in-test at every level of maintenance to eliminate "retest okay" and "could not duplicate conditions" once the equipment has been deployed. In-house enhancements have been made to on-line logistics support analysis programs to provide products which document supportability with the user in mind. Logistics support analysis data is derived from the same database used by design and test engineering. The on-line LSA database can be accessed by manufacturing, design, and logistics groups.

TRAINING MATERIAL AND EQUIPMENT

Fully Documented Training Courses

Training is a part of the logistics operation in the logistics directorate. Responsibilities of the training organization include defining the customers training requirements, preparing course materials, conducting formal courses (laboratory and lecture), and providing video training. All training courses are fully documented and subjected to in-process reviews. These courses provide the customer with initial hardware and software training. This material is also used to train personnel required to perform development and operational testing. Training materials and equipment match maintenance plans. They visit field activities to assist in the development of training requirements. A major key to their success is early involvement in the design process.

TECHNICAL MANUALS

Technical Manuals

The development of technical manuals is keyed to support of training requirements, engineering development models, equipment evaluation, initial production units, and update of programs. They provide general descriptions, operating procedures, theory, installation procedures, and maintenance procedures. Equipment and procedures documented within technical manuals are based on the engineering documents and Logistics Support Analysis Record which documents the design and maintainability aspects of every system. Technical writers obtain first hand information from design engineers and supportability personnel. Their efforts are proven during validation and verification processes which follow the guidelines of technical manual contract requirements. All manuals are developed and produced on the latest automated equipment available to the industry. Technical accuracy of the manuals is traceable through the engineering control system, configuration management system, and Logistics Support Analysis Record database.

2.6 MANAGEMENT

MANUFACTURING STRATEGY

Process Improvement Team

A concept identified as Process Improvements Team(s), which was intended to improve production through process change, has been initiated. These teams consist of three people: the manufacturing engineer, the operator involved, and the first line supervisor.

The team meets at least once a week to discuss any process problems that the operator is experiencing, or any improvements that could be made to the process that the operator is working with. This concept is implemented only in areas where Statistical Process Control (SPC) is being used. There are at least two ways in which they may benefit from this:

- A regular channel of communication is established and exercised between the manufacturing engineer, operator, and supervisor.
- Through these meetings, the operator has an equal opportunity to offer suggestions to change the existing process, and by so doing, improve the yield and/or process.

DATA REQUIREMENTS

Data Management

The method of data management used is innovative and thorough. The fact that data management is a function of the logistics division is also somewhat unique. All data information required by a statement of work for any request for quotation or proposal is handled and monitored by one office, the Data Manager, in order to eliminate confusion and duplication of effort.

The Data Manager assigns and controls data responsibility to functions by the use of a matrix form which lists required data items and various functions. This form not only clearly establishes responsibility for data items, but it also serves to document the requirement for data to be submitted, thereby eliminating chances for data requirements to be overlooked. A similar method is used to flow-down data requirements to subcontractors. The criticality of data management has been recognized and a system is in-place that allows those critical requirements to be met.

SECTION 3

PROBLEM AREAS

The practices listed in this section were identified by ITTAV to the BMP survey team as being potential electronics industry wide problems.

3.1 DESIGN

PARTS AND MATERIALS SELECTION

Design for Automation

Mil Spec parts have a wide dimensional tolerance, which is inconsistent with Design For Automation (DFA) applications. These wide tolerances make it difficult for automated component application.

3.2 PRODUCTION

QUALIFY MANUFACTURING PROCESS

Soldering Specifications

Contractural requirements are established to maintain personnel certification to soldering specifications such as DOD-STD-2000. There is a long lead time in obtaining this certification and the availability to acquire this certification is limited.

A need is seen to incorporate the DOD-STD-2000 as a single working specification for high reliability soldering. Problems are created when more than one specification is imposed.

Part Marking

Difficulty in part or component marking and the permanency of the marking was identified as a problem. This problem has been identified on previous surveys and has been forwarded to the Electronics Manufacturing Productivity Center (EMPF) for investigation.

SECTION 4

SUMMARY

ITTAV's preparation for this BMP survey is worthy of note. Many best practices were observed by the survey team. A thorough effort was done at ITTAV in reviewing their internal processes and practices in conjunction with their familiarization of the templates of the DoD 4245.7-M, "Transition From Development to Production." The familiarity with the templates and how they related to ITTAV's policies and practices was evident during the course of the survey.

Design policy and the design process incorporated design for production as an issue. The automated analysis system, RAMCAD, along with the various CAE/CAD/CAM tools and the way in which these tools and systems were interfaced and networked was notable. Also, the logistics issues in the design of the product are addressed at the early stages. All of these aspects are incorporated in order to have a producible and reliable design with a better transition to manufacturing.

Use of statistical process control in many manufacturing operations was very evident. Use of the Taguchi methods have been incorporated into the drilling and wave soldering processes to reduce defects in producing a quality product. Planning and making capital investments for modernization, taking into account new manufacturing methods and processes, were also evident.

The point of contact for this BMP survey is:

Mr. Edmund Stuczynski
Vice President
Director of Manufacturing
(201) 284-4392

ITT
Avionics Division
100 Kingsland Road
Clifton, New Jersey 07014-1904

His cooperation, time, and quality of effort in preparation and hosting of this survey at ITT and participation in the Best Manufacturing Practices Program is greatly appreciated.